Chapter Fifteen

INTERCHANGE TYPE AND DESIGN STUDIES

BUREAU OF DESIGN AND ENVIRONMENT MANUAL

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CHAPTER FIFTEEN
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Chapter 37 presents criteria for determining the warrants, application, and selection of various interchange types.

15-1 INTERCHANGE TYPE STUDIES AND ADDITIONS

The functional classification of the crossroad has a significant impact on whether an interchange is warranted and the type of interchange selected. In addition, traffic operations (e.g., freeway ramp terminal spacing, mainline weaving, level of service, signing) may affect the interchange type and spacing, especially in urban areas. The following sections present guidelines on the preparation and processing of Interchange Type Studies.

15-1.01 Purpose of Interchange Type Studies (ITS)

Interchange Type Studies are prepared to gain BDE concurrence for the preferred type, to aid in developing the design of the selected type, and to minimize the number of man-hours used before detailed design studies are initiated. When a corridor/design study is initiated for a new freeway or expressway, the Phase I project study group prepares a brief report that includes proposed interchange locations and describes the proposed interchange type at each location.

An existing freeway may require an additional interchange due to urban development or due to lack of proper access to an area, or an expressway may require the upgrading of an existing intersection to an interchange. In all cases, the proposal to provide an interchange must be justified and documented and may require an Interchange Type Study. Section 37-1 provides the guidelines for justification of need, and the results of the entire Study are documented in a report entitled “Request for Additional (Modified) Interstate (Freeway or Expressway) Access.”

As part of the access report, include the necessary information as discussed in Chapter 19 and in Part III, Environmental Procedures, that demonstrates the public benefits and need for an interchange (i.e., the “Purpose and Need”). See Chapter 35 for details on access control along the crossroad.

If the district determines that a conventional diamond or parclo Type C interchange is the most appropriate type of interchange at a particular location, an Interchange Type Study is not required and, therefore, no submittal to BDE is necessary. However, if the district determines that such a review is beneficial, Interchange Type Studies may be prepared and submitted to BDE for review and approval.

For complex interchanges, BDE involvement in type studies is required because of the larger number of alternatives requiring analysis and the typically higher costs. Complex interchange designs usually require more supporting information, such as:

- crossroad, ramp, and mainline profiles;
- access restrictions;
- weaving analyses;
- capacity analyses of entrance and exit terminals;
- lane balance;
- route continuity coordination;
- preliminary signing plans;
- topography;
- existing cultural developments; and
- cost estimates.

If sufficient detail is submitted to BDE with the Interchange Type Study, geometric approval may be provided concurrently with interchange type approval.

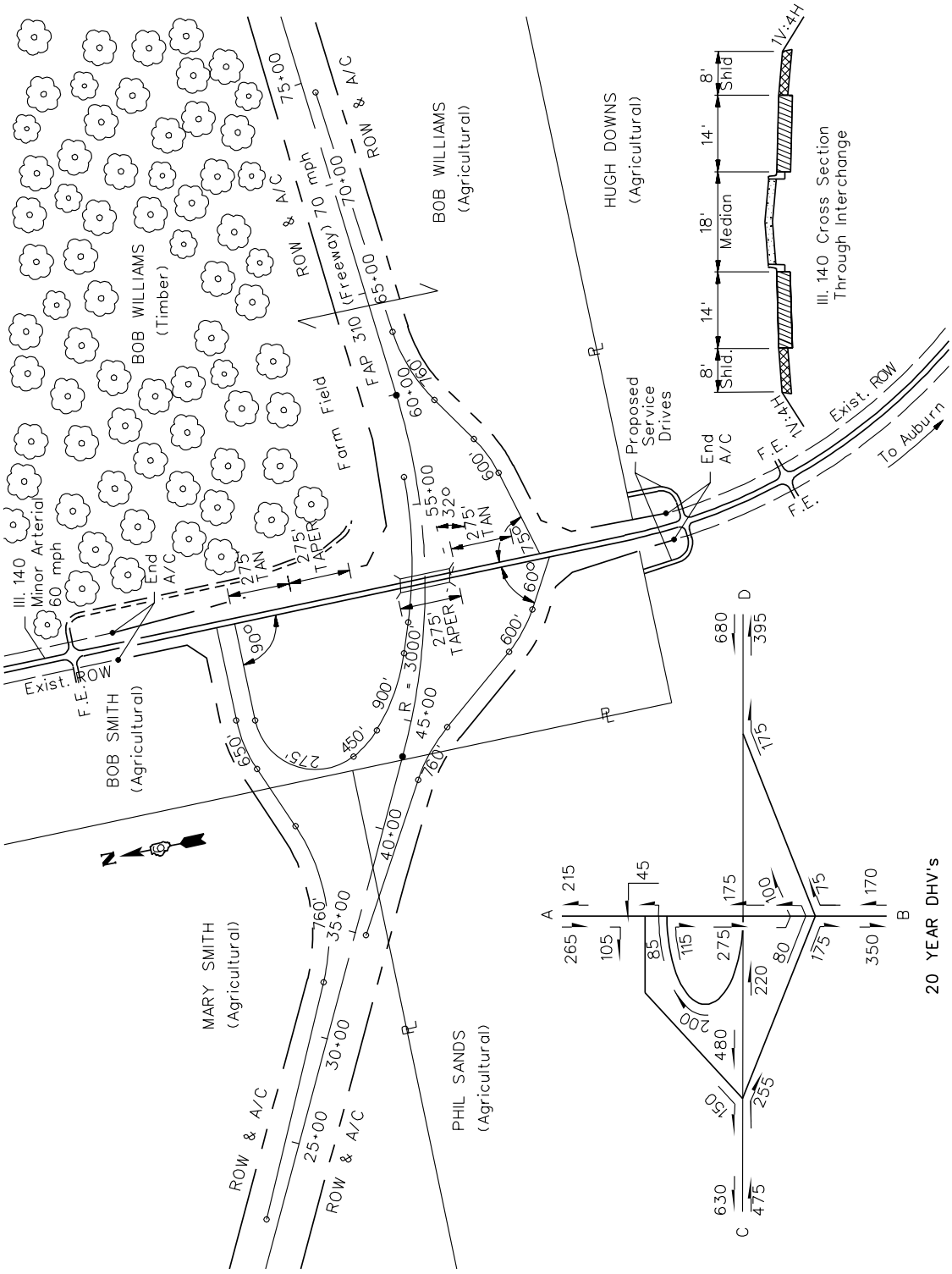
15-1.02 Guidelines for Preparing Interchange Type Studies

Use the following guidelines to prepare the Interchange Type Study:

1. Base Exhibits. Prepare a schematic drawing of the interchange layout on a print of an aerial mosaic or aerial mapping using a scale of 1 in = 400 ft (1:5000 metric) or 1 in = 600 ft (1:7500 metric). For complex interchanges, use a scale of 1 in = 200 ft (1:2500 metric) for rural areas and either a 1 in = 100 ft (1:1000 metric) or 1 in = 50 ft (1:500 metric) scale for urban areas. Figure 15-1A illustrates a typical schematic drawing of an interchange layout. In addition, it is desirable to include a county map and a 0°7′30″ quadrangle map as exhibits with the ITS. In urban areas, also include a city map showing the proposed interchange location(s).

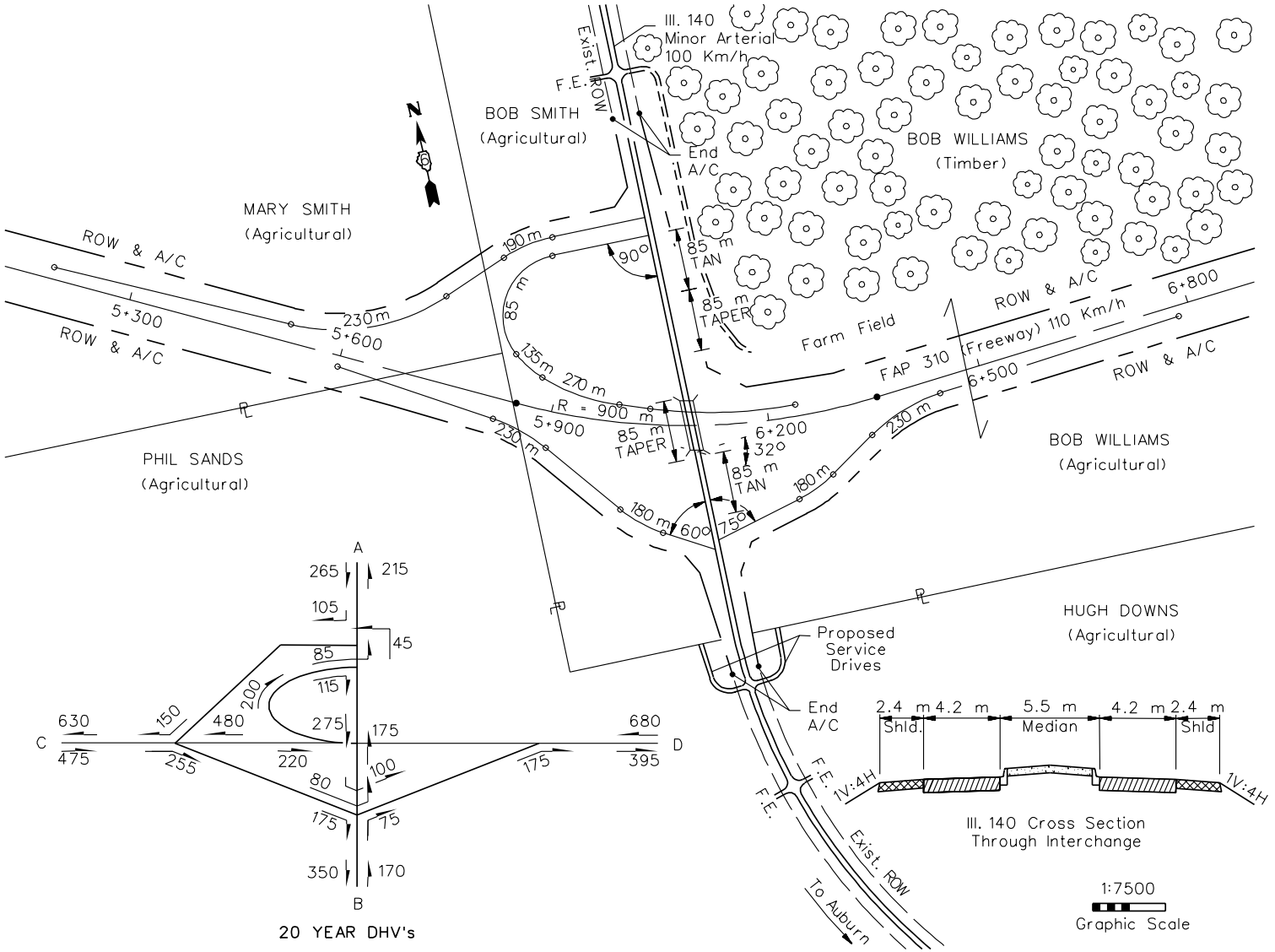
2. Alternatives. When interchange type selection is controversial, prepare alternative schematics on separate aerial mosaics. Indicate which alternative is preferred and the rationale used in the selection.

3. Content. Schematic drawings may be prepared in the form of a single-line diagram. Show the layout of the mainline, crossroad, and ramps. Include the following information:



TYPICAL SCHEMATIC OF AN INTERCHANGE TYPE STUDY
(US Customary)
Figure 15-1A

Note: Sketches for type approval are normally drawn on aerial photography, and the sketch in this figure depicts the usual features shown on the photography.



Note: Sketches for type approval are normally drawn on aerial photography, and the sketch in this figure depicts the usual features shown on the photography.

TYPICAL SCHEMATIC OF AN INTERCHANGE TYPE STUDY
(Metric)

Figure 15-1A

- traffic flow diagram for projected DHV (e.g., typically based on 20 years);
- functional classification, design speed, and design traffic volumes of both routes;
- angle of intersection between mainline and crossroad;
- angle of intersection between ramps and crossroad;
- typical cross sections, including shoulder widths;
- all existing and proposed radii of ramps and roadways;
- lengths of left-turn lanes and taper rates;
- limits of access control along the crossroad;
- limits of ramps on the mainline and crossroad;
- any proposed structures;
- any proposed local road relocation and frontage roads or service drives;
- property lines and names of land owners; and
- any relevant photographs of the area.

4. Special Conditions. List any special conditions (e.g., wetlands, historic site, archeological site) that support the development of an unusual interchange type, and include all necessary elements that control the design. Provide a statement regarding satisfactory alignments and profiles in conjunction with the design. If the development of preliminary profiles are necessary, include them with the ITS.

15-1.03 Processing Interchange Type Studies

The district is responsible for preparing the Interchange Type Study. The district should submit the study to BDE for review, concurrence, or approval, as necessary.

Once the type study, interchange addition, or proposed change in access has been accepted by BDE and, where necessary FHWA, the district office may initiate the preparation of the Interchange Design Study as discussed in Section 15-2.

15-2 INTERCHANGE DESIGN STUDIES

Interchange Design Studies (IDS) are required for all interchange facilities. After the interchange type approval has been received, preparation of the IDS can be initiated. However, before design work is started, a field review should be made to each interchange location. The following sections discuss the guidelines and procedures for preparing an IDS.

15-2.01 Guidelines for Preparing Interchange Design Studies

IDS base sheets are standardized and available on CADD files. These standardized sheet sizes along with formatting details are used in developing IDSs. In general, prepare the IDS in the same manner as an intersection design study; see Chapter 14 for format details. Figures 15-2A, 15-2B, 15-2C, 15-2D, and 15-2E illustrate the typical format that should be used for uniformity on IDS plans. In addition, consider the following guidelines:

1. General.

   a. Drafting. The entire IDS is prepared on CADD. A controlled-scale aerial mosaic or aerial mapping usually is the base for development of the IDS. This base is the visual description of the existing topography. Photographic inserts may be added for additional clarification.

   b. Scales. For interchange designs on new alignment, use topographic mapping at 1 in = 200 ft (1:2500 metric) for the interchange layout. This scale allows the entire interchange to be shown on one sheet without match lines and also allows all property lines and roads to be shown around the interchange. If the interchange is being developed as a result of a planned upgrade of an existing route, usually an expressway design, use a scale ratio of either 1 in = 100 ft (1:1000 metric) or 1 in = 50 ft (1:500 metric). Also, for interchange designs in urban areas, the same scale ratios of either 1 in = 100 ft (1:1000 metric) or 1 in = 50 ft (1:500 metric) may be used. Larger scales aid in the decision-making process, especially where cultural land development or elevation restrictions are an issue.

2. First Sheet. Include the following information on the first sheet:

   a. Topography/Cultural Features. Include all houses, businesses, major utilities, roads and streets, right-of-way, access control lines, and structures on the topographic mapping. If contour lines are desired, plot them as light lines so they do not detract from the line work of the proposed interchange.

   b. General Notes. Include references to design exceptions, crash data, cultural development, terrain, improvement type, etc. See Section 14-3 for additional information.

c. Elements Controlling Design. Chapter 37 presents the design criteria for interchanges. On Sheet No. 1, list all pertinent elements affecting the design of the interchange.

d. Interchange Layout. Include horizontal alignment details, stationing, and proposed structures.

e. Capacity Analysis Table. For ramp/crossroad intersections, include the capacity analysis table in the upper left-hand corner. This table summarizes the results of the capacity analysis. See Chapter 14 for an example of the format.

3. Second Sheet. Show the details for each ramp/crossroad intersection, any specially designed free-flow terminals, and how the crossroad turn lanes are designed. If more space is needed, use an additional sheet for details. See Figure 15-2B. Select a scale that will allow the details to be clearly shown. Include the capacity table for free-flow ramp terminals; see Figure 15-2F. If weaving areas are proposed, also include a weaving analysis table as illustrated in Figure 15-2G. This table should include a summary of the ramp capacity analysis and the number of lanes required.

4. Profiles. After the crossroad details, show the profiles for the mainline and crossroad through the interchange; see Figure 15-2C. Next, include the profiles for each ramp; see Figure 15-2D. Where necessary, include detailed profiles for each turning roadway at the ramp crossroad intersections.

5. Cross Sections. After the profile sheets, show all the necessary controlling cross sections adjacent to the mainline, a cross section for the mainline, if applicable, and a typical section of the ramp proper; see Figure 15-2E. Figures in Chapter 37 indicate the locations where controlling ramp cross sections should be taken.

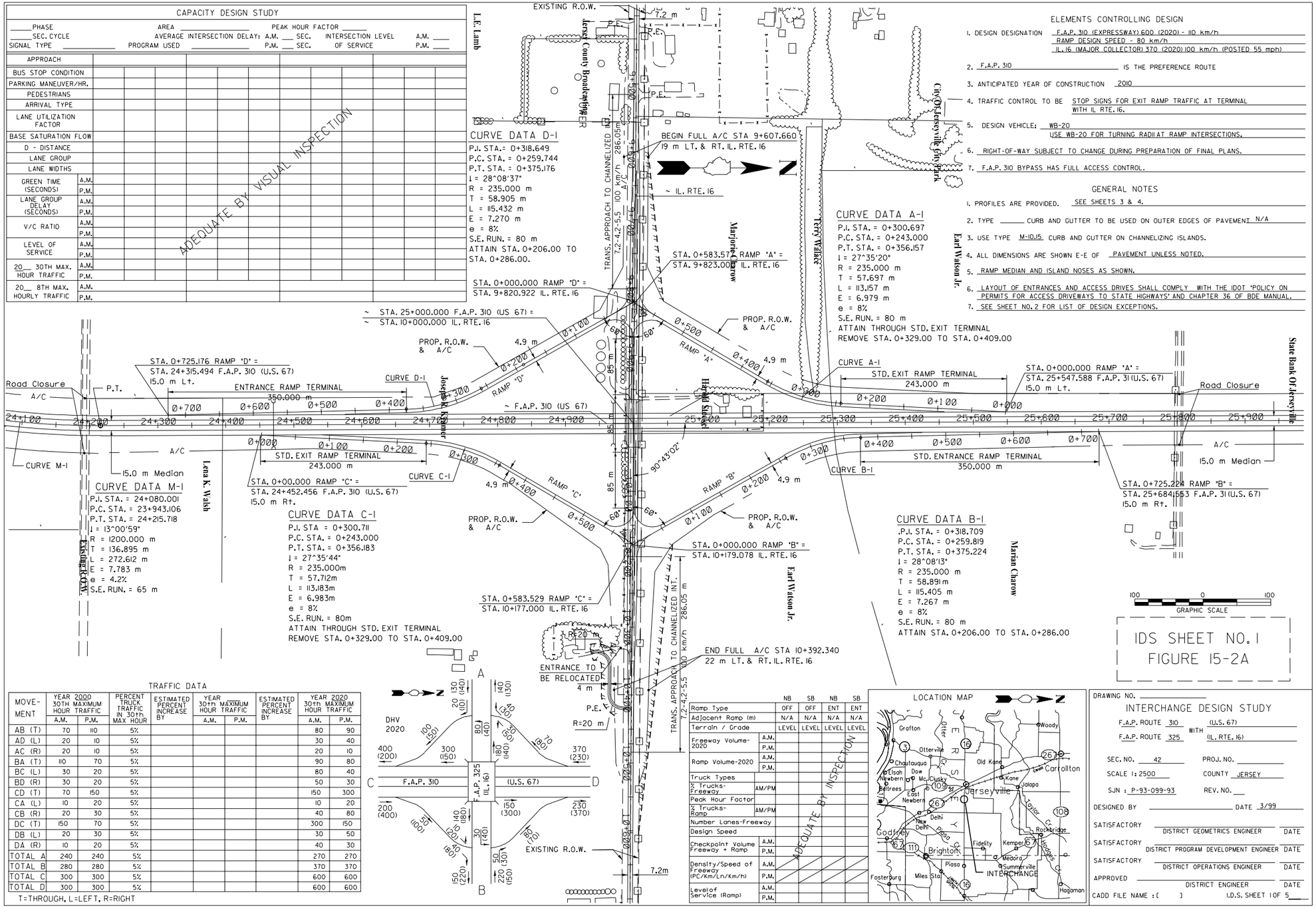
6. Interchange Models. For very complex interchanges, it may be desirable or necessary to prepare a model for evaluating alternative interchange design features. This can be accomplished using a computer software package (i.e., GEOPAK) or by preparing a simple, three-dimensional model. The model may be developed by mounting the plan layout onto thin cardboard and then pasting the mainline, crossroad, and ramp profiles onto the plan sheet of the roadway alignment.

15-2.02 Processing Interchange Design Studies

The Interchange Design Study is prepared under the direction of the District Geometrics Engineer. Once the IDS has been reviewed and approved by the applicable district personnel, forward the IDS to BDE for review and approval. With the IDS plan sheets, include a memorandum detailing the major design features of the interchange. Where necessary, after BDE has completed its review and approval, BDE will forward the IDS to FHWA for its review and concurrence.

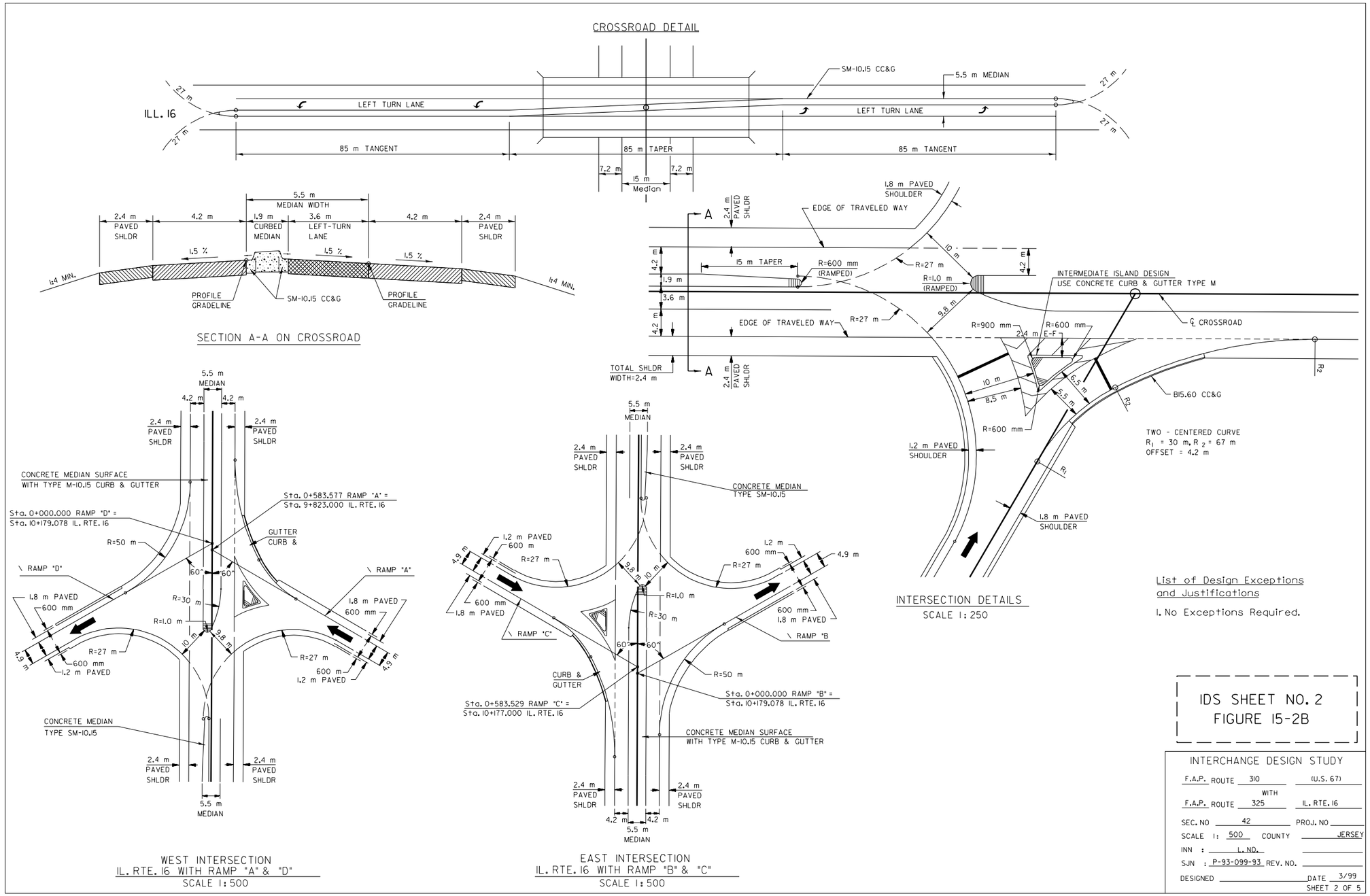
After approval of the geometrics and capacity analysis by BDE and, where necessary, by FHWA the district office will be notified in writing that the interchange design is satisfactory. This notification allows the IDS to be included in the Phase I report, and it can then be used for public involvement activities. Without BDE approval and, when necessary, FHWA concurrence, an IDS cannot be used for public involvement activities.

Final approval of an Interchange Design Study is given with design approval of the Phase I report or Request for Additional Freeway Access Report. This final approval ensures that the social, economic, and environmental factors have been properly considered. Once the Phase I report has been approved, the IDS can then be used in the preparation of the detailed construction plans.



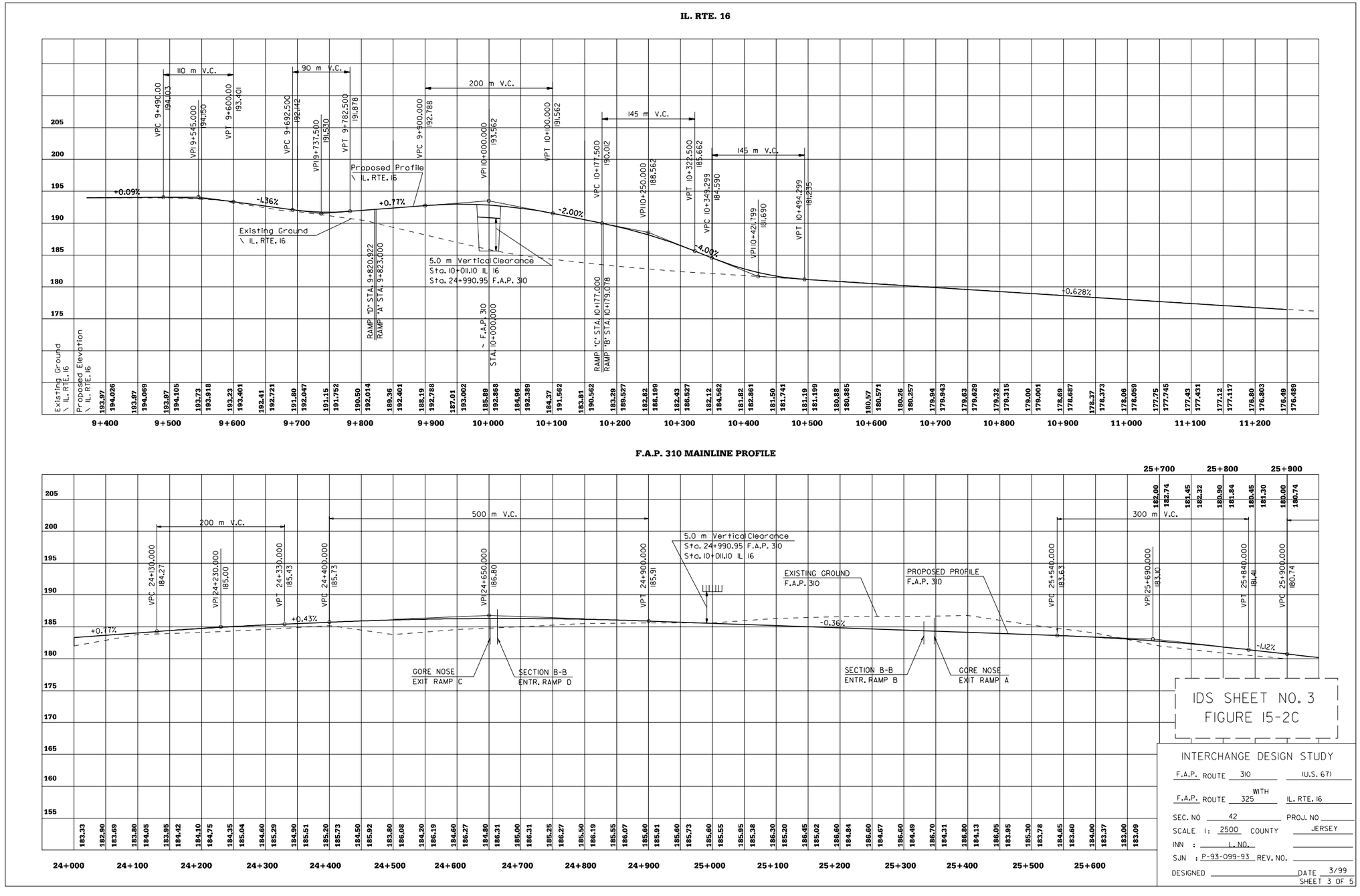
EXAMPLE IDS SHEET
(General Layout — First Sheet)

Figure 15-2A



EXAMPLE IDS SHEET
(Ramp Crossroad Details — Second Sheet)

Figure 15-2B



F.A.P. 310 MAINLINE PROFILE

IDS SHEET NO. 3
FIGURE 15-2C

INTERCHANGE DESIGN STUDY

F.A.P. ROUTE 310 (U.S. 67)

F.A.P. ROUTE 325 WITH IL. RTE. 16

SEC. NO 42 PROJ. NO

SCALE 1: 2500 COUNTY JERSEY

INN : L. NO.

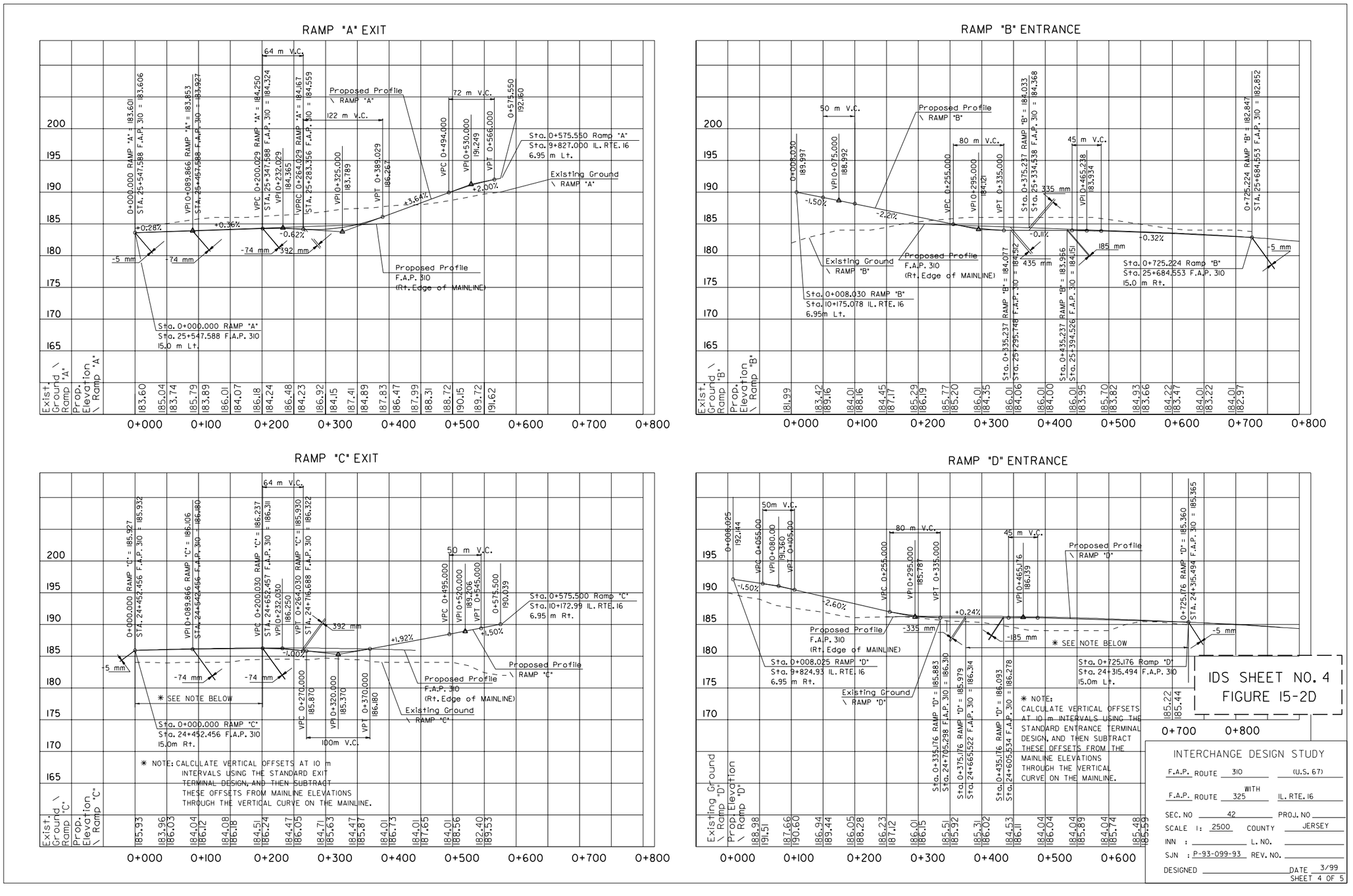
SJN : P-93-099-93 REV. NO.

DESIGNED DATE 3/99

SHEET 3 OF 5

EXAMPLE IDS SHEET
(Mainline and Crossroad Profiles)

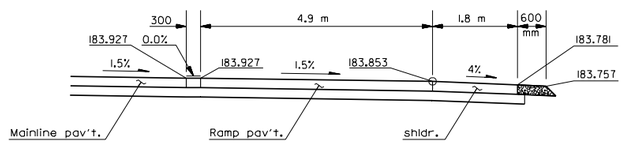
Figure 15-2C



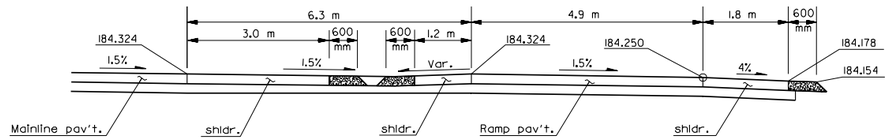
EXAMPLE IDS SHEET
(Ramp Profiles)

Figure 15-2D

CROSS SECTION DETAILS AT RAMP TERMINALS

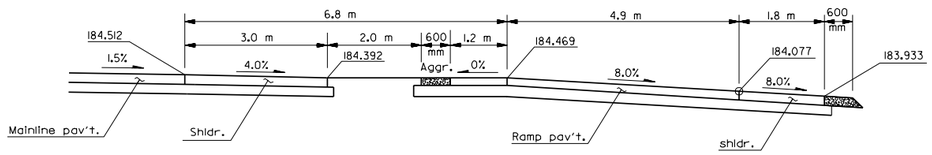


SECTION B-B
STA. 0+089.87



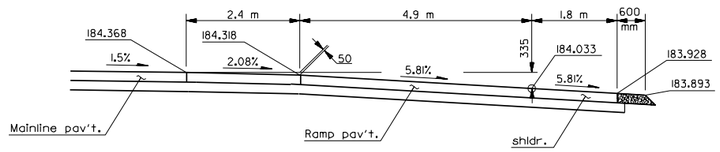
SECTION C-C (Ahead)
STA. 0+200.02

RAMP "A"
EXIT TERMINAL

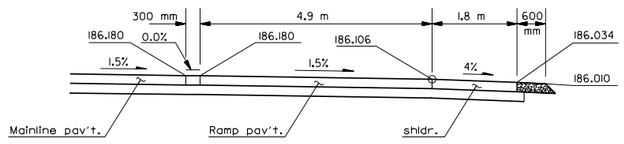


SECTION A-A
STA. 0+335.24

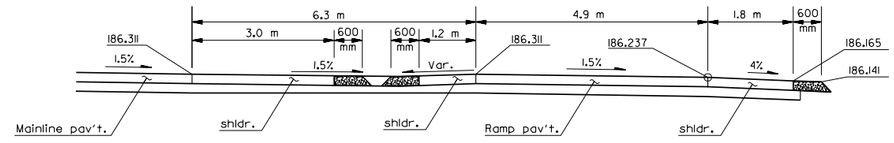
RAMP "B"
ENTRANCE TERMINAL



SECTION B-B
STA. 0+375.24

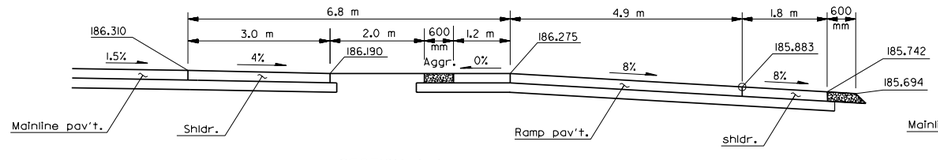


SECTION B-B
STA. 0+089.87



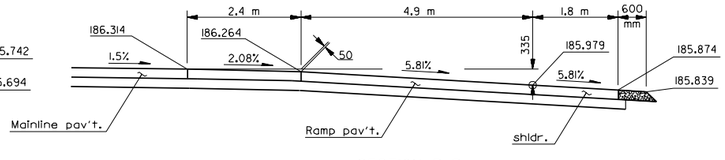
SECTION C-C (Ahead)
STA. 0+200.02

RAMP "C"
EXIT TERMINAL



SECTION A-A
STA. 0+335.18

RAMP "D"
ENTRANCE TERMINAL



SECTION B-B
STA. 0+375.18

IDS SHEET NO. 5
FIGURE 15-2E

INTERCHANGE DESIGN STUDY

F.A.P. ROUTE 310 (U.S. 67)
WITH
F.A.P. ROUTE 325 IL. RTE. 16
SEC. NO 42 PROJ. NO
SCALE 1: 500 COUNTY JERSEY
INN : L. NO.
SJN : P-93-099-93 REV. NO.
DESIGNED DATE 3/99
SHEET 5 OF 5

EXAMPLE IDS SHEET
(Cross Sections)

Figure 15-2E

Ramp Type					
Distance to Adjacent Ramps (ft (m))					
Terrain/Grade					
Freeway Volume	A.M.				
	P.M.				
Ramp Volume	A.M.				
	P.M.				
Truck Types					
% of Trucks on Freeway					
Peak-Hour Factor					
% Trucks on Ramp					
Number of Lanes on Freeway					
Design Speed					
Checkpoint Volume (Freeway + Ramp)	A.M.				
	P.M.				
Density/Speed* (PC/mi/LN)/(mph) (Freeway)	A.M.	/	/	/	/
	P.M.	/	/	/	/
Level of Service (Ramp)	A.M.				
	P.M.				

**Note:* *The prediction of density and the model to determine this variable are discussed in the HCM. Density is measured in passenger cars per mile (kilometer) per lane (PC/mi/LN (PC/km/LN)). The average travel speed may be predicted within the ramp influence area, but should not be used as a primary measure of level of service.*

ENTRANCE AND EXIT RAMP TERMINAL CAPACITY TABLE

Figure 15-2F

Weaving Section					
Terrain/Grade					
Type of Weave					
Number of Total Lanes					
Length of Weaving (ft (m))					
Volume 1 (Through Volume)	A.M.				
	P.M.				
Volume 2 (Exit Weave)	A.M.				
	P.M.				
Volume 3 (Entrance Weave)	A.M.				
	P.M.				
Volume 4 (Ramp-Ramp)	A.M.				
	P.M.				
Truck Types					
% Trucks					
% Other Vehicles					
Population Factor					
Level of Service (Weaving Vehicles)	A.M.				
	P.M.				
Level of Service (Non-Weaving Vehicles)	A.M.				
	P.M.				
Weaving Speed	A.M.				
	P.M.				
Non-Weaving Speed	A.M.				
	P.M.				
Constrained/Unconstrained					

TABLE FOR WEAVING ANALYSIS

Figure 15-2G